
Space Weather Technical Forecast

Issued on Friday, 03 June 2022 at 13:25 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Active Electron Fluence. Chance of G1/Minor Storm intervals with a slight chance of G2/Moderate Storm either later Day 3 or early Day 4 (05-06 June) from possible CME arrival(s).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Very Low, with no significant flares during the period. There are four sunspot regions on the visible disc, with the most prominent AR3026 (Dso/Beta) in the northwest quadrant and AR3027 (Dso/Beta) in the southern central disc. The latter is of interest due to its reverse polarity for a SC25 southern hemisphere spot; also known as an 'Anti-hale region'. The other two regions are small unipolar spots. No Earth-directed CMEs have been observed in available imagery in the past 24-hours.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1, has been at background levels through the period, reducing from around 370km/s to 320km/s. Density has been predominantly below average, only increasing to normal levels from around 03/1135 UTC. The interplanetary magnetic field strength, Bt, has been weak (below 5nT), with the north-south component, Bz, varying weakly between +/-4nT, but largely in the negative direction. Phi angle was predominantly negative (towards the Sun). Geomagnetic activity was Quiet (Kp 1-2).

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) has been at background levels. The high energy electron flux (greater than 2 MeV) has been predominantly at High levels, reaching a peak of 9250 pfu at 02/1550 UTC. Electron fluence has been above the Active threshold throughout, reaching 3.95e8 integrated pfu at 03/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low to Very Low, with a chance of C-class flares and a slight chance of M-class flares, primarily from AR3026 or AR3027.

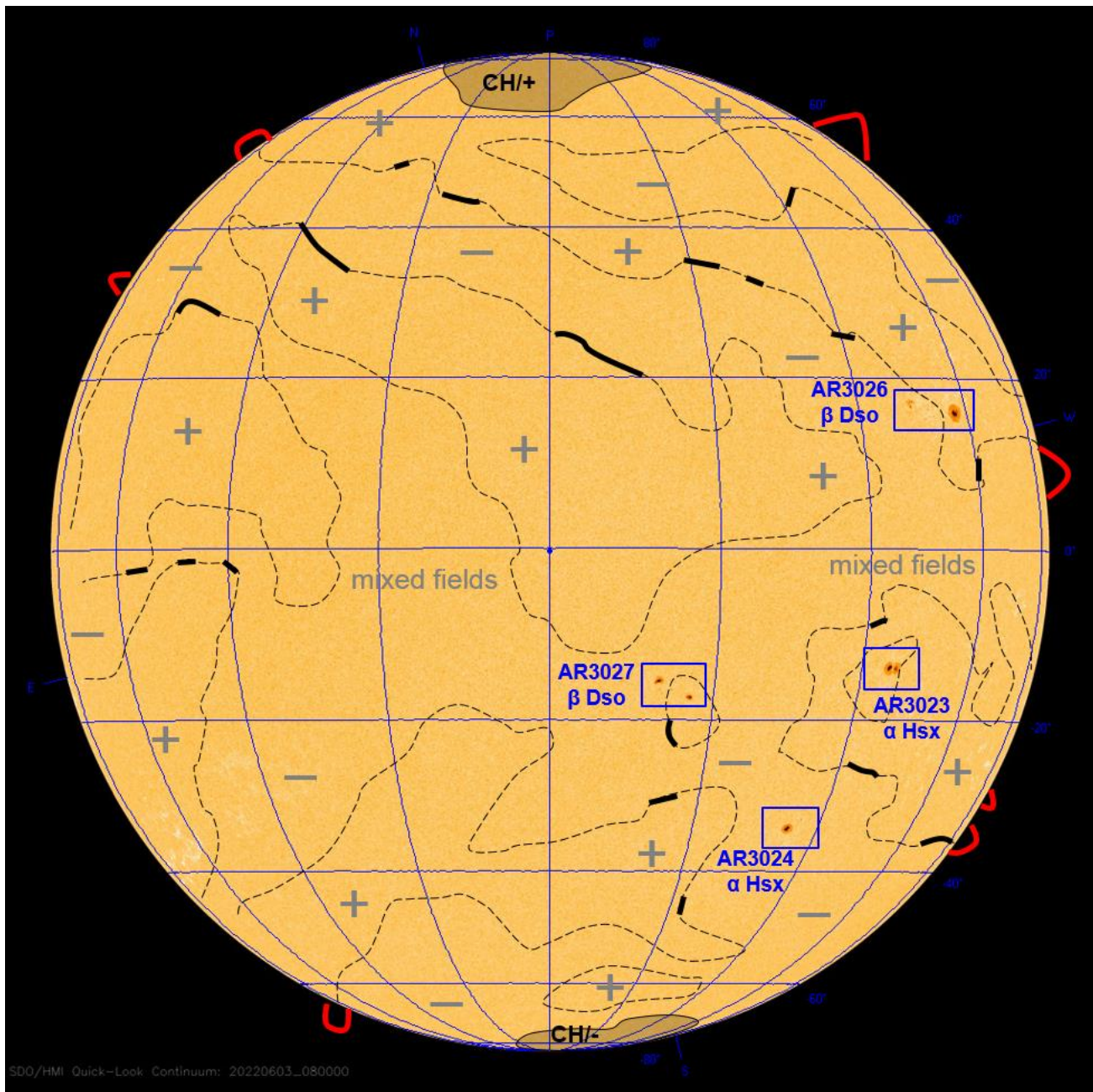
Solar Wind / Geomagnetic Activity: Two filament lift-offs have been observed, the first around 01/0100 UTC, and the second around 02/0530 UTC. They have both given CMEs with the potential for a glancing blow at Earth. These two CMEs may combine for an arrival either later on Day 3 (05 June) or during Day 4 (06 June). Both CME assessments carry low confidence, however.

Aside from the CMEs, background wind speeds are expected to persist through the period. Geomagnetic activity is forecast to be predominately Quiet through to Day 3, but increasing to Unsettled to Active with a chance of G1/Minor Storm, and a slight chance of a G2/Moderate Storm, if we see the CME(s) either later Day 3 or early Day 4.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is expected to be at background levels during this period. High energy electron flux (greater than 2MeV) is likely to continue at mainly High levels, with peak values only gradually easing later in the period, perhaps dropping out on Days 3 or 4 (05 or 06 June) due to any CME arrival. Electron fluence levels are expected to be Active throughout (1e8 integrated pfu), likely declining by the end of the period, but again perhaps dropping out if we see a CME arrival.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

Figure 1. Solar Analysis Valid 03/0800 UTC.



Key: Filament — , Prominence — , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - $\beta\gamma$ - $\beta\gamma\delta$ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

A filament lift-off was observed from the centre disc around 01/0100 UTC, with an associated coronal dimming. A weak CME was produced, which has been assessed as a slow CME, giving a slight chance of a glancing blow. A further filament eruption was observed leaving the southwest disc around 02/0530 UTC. This has also given a CME with the potential for a glancing blow. These two CMEs may combine for an arrival either later on Day 3 (05 June) or during Day 4 (06 June). Both CME assessments carry low confidence however.

Aside from the CMEs, background wind speeds are expected to persist through the period with no notable coronal hole fast wind enhancements expected.

Geomagnetic activity is forecast to be predominately Quiet through to Day 3, but increasing to Unsettled to Active with a chance of G1/Minor Storm, and a slight chance of a G2/Moderate Storm, if we see the CME(s) either later Day 3 or early Day 4.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	1	1	30	30
Strong	G3	No	1	1	2	2
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

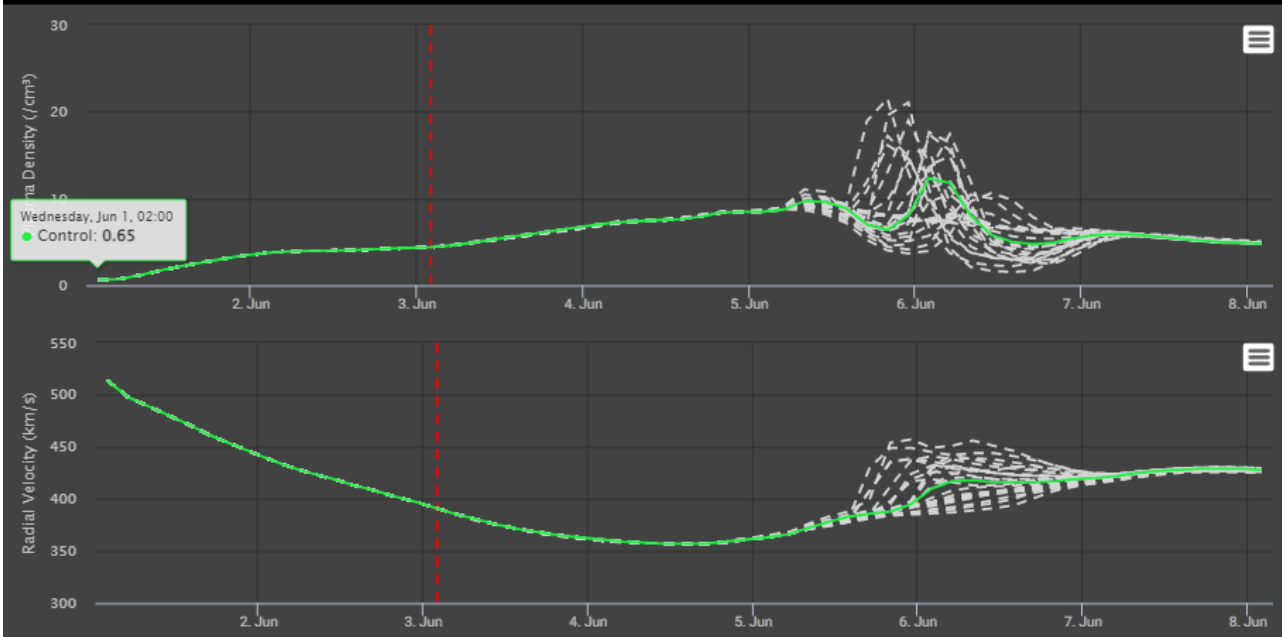
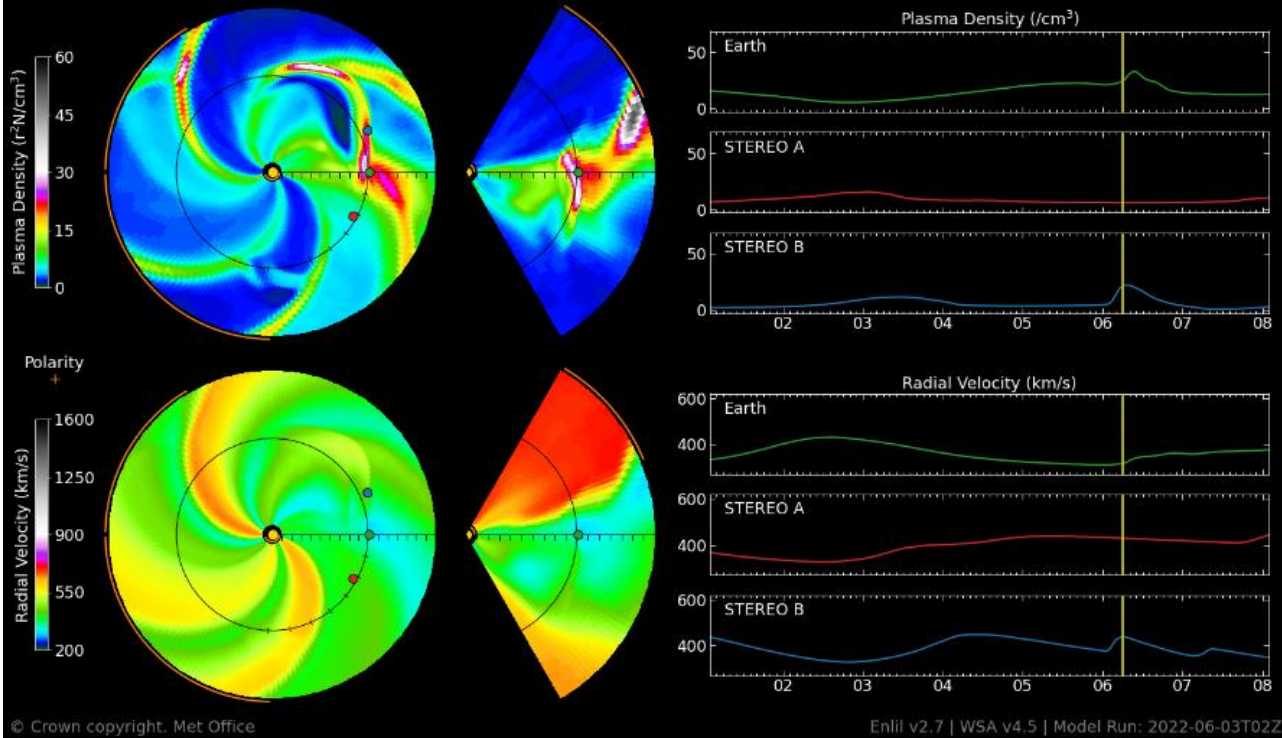
Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
01/1300	Partial	Filament	4N 10W	252	05/1800 +/- 12 hours	Limited shock. Weak and low confidence.
02/1315	Partial	Filament	6S 45W	525	06/0000 +/- 12 hours	Glancing blow possible. Low confidence.

Figure 2: Enlil and ensemble, indicating a possible CME arrival (s) either late on 05 or on 06 June.



2022-06-06 06:00:00



Radio Blackouts - X-Ray Flares:

Solar activity is currently Very Low, with no significant flares observed in the past 24-hours.

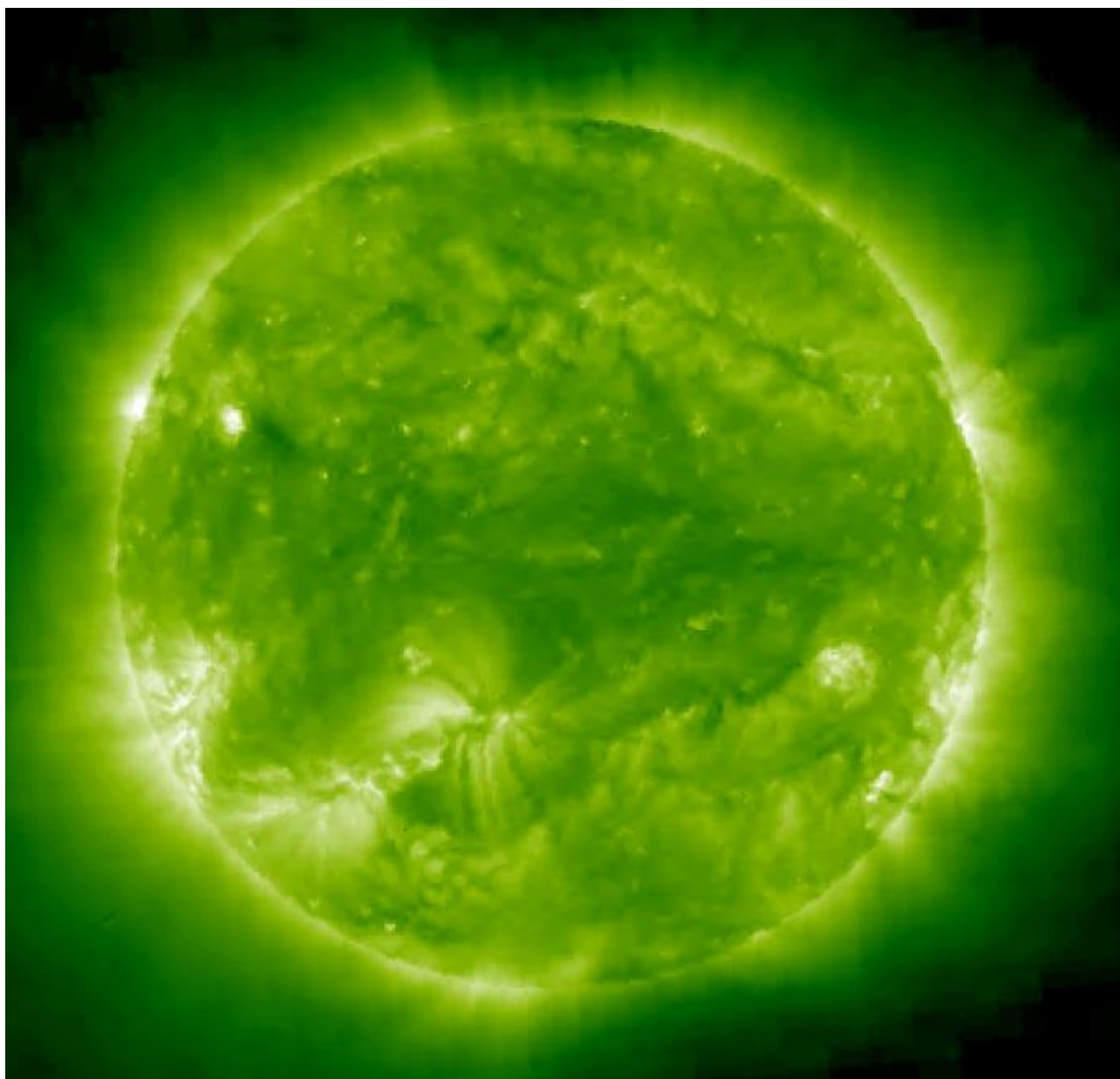
There are four numbered sunspot regions on the visible disc. AR3026 continues to evolve after earlier gaining sufficient penumbra on the trailer spots to be classified as a Dso/Beta group. However, since the previous analysis was completed, the penumbra of the trailer portion of the group has largely faded and may soon be reclassified as a Cso/Beta group. AR3027 (Dso/Beta) near the south centre disc has some interest due to its reverse magnetic polarity for a southern hemisphere spot according to Hale's Law. The other two regions are small and simple unipolar regions.

STEREO-A EUVI imagery is indicating a bright flux region near the eastern limb in the southern hemisphere and would be expected to soon rotate onto the visible disc as apparent from Earth. A plage region on the eastern limb of SDO/HMI imagery appears to be from this area of interest and so will be closely monitored as it rotates into clearer view in the coming days.

Activity is expected to remain Low to Very Low with a chance of C-flares, and a slight chance of rising to Moderate due to isolated M-flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	10	10	10	10
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: STEREO-A EUVI 195 imagery at 03/0835 UTC indicating bright flux region(s) in far southeast, soon to rotate onto Earth-facing disc.



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is at background levels and is expected to remain at this level, with AR3026 having simplified in the last 24 hours.

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	1	1	1	1
Very Active	$\geq \text{S3}^*$	No	1	1	1	1

* S3 $\geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)

High Energy Electrons Event ($\geq 2 \text{ MeV}$):

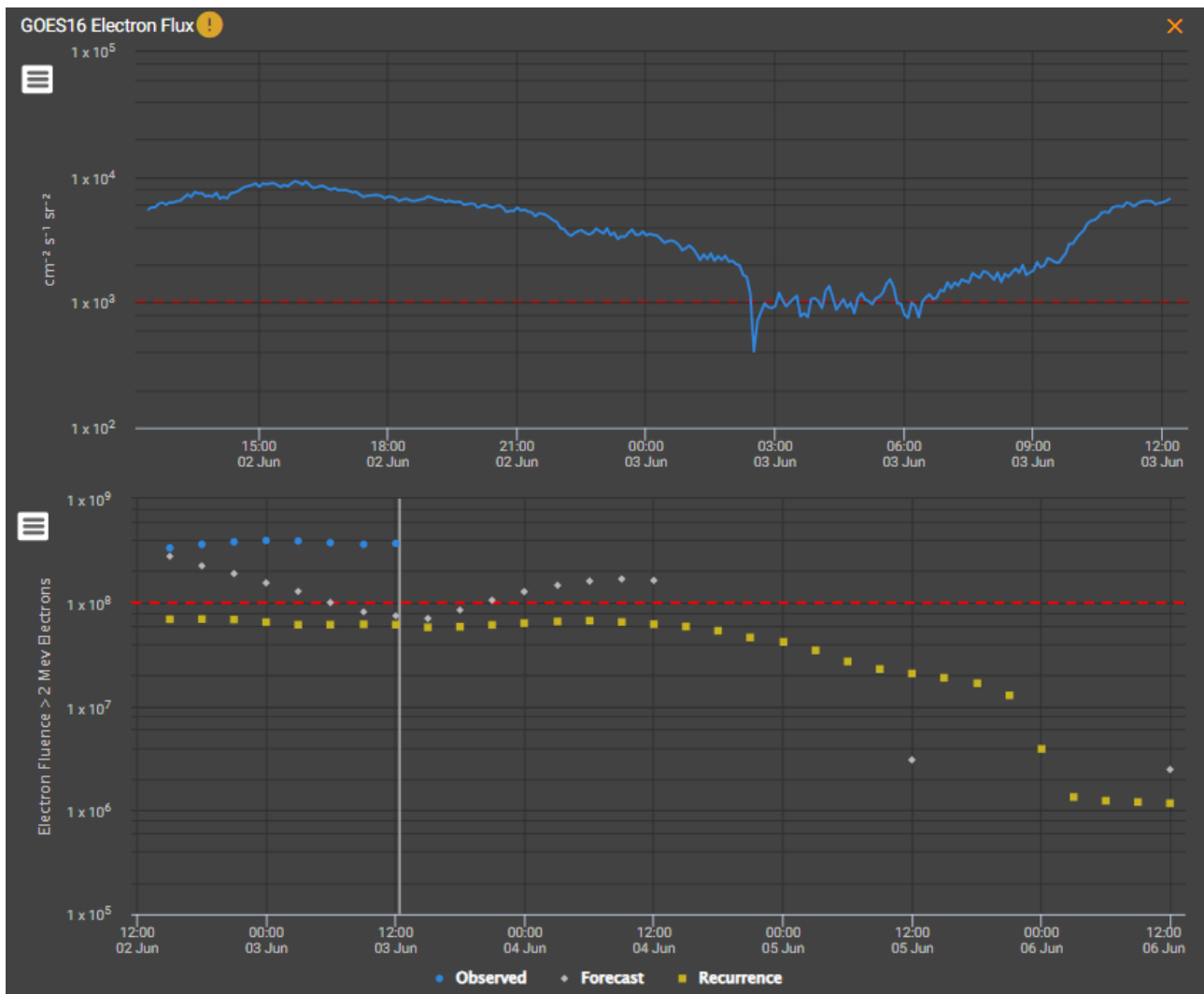
The high energy electron flux (greater than 2MeV) as observed by GOES-16 has been at High (greater than 1000pfu) levels through the last 24 hours due to the recent fast wind enhancement. With no further notable disturbances forecast for the solar wind environment at Earth through to Day 3 (05 June), these mainly High levels are expected to persist, although peak values are likely to gradually decline. However, either later on Day 3 or early on Day 4 (06 June) the potential for CME arrival(s) will bring the chance of flux levels dropping out.

The associated 24 hour electron fluence is currently Active (greater than $1\text{e}8$ integrated pfu) and is likely to persist at this level through the period, but any CME arrival could cause a dropout either later on Day 3 or early on Day 4. REFM is showing a fairly rapid decline in fluence levels on Day 2 and 3, which is thought to be too fast as electron levels usually take a period of time to decline in the absence of CME influence.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1\text{x}10^8$	Yes	100	90	70	60
Very Active	$\geq 2 \text{ MeV}$ $\geq 1\text{x}10^9$	No	2	2	1	1



Figure 4: GOES16 Electron Flux and MOSWOC REFM model output and observed fluence values



NOTE: Our REFM model has been upgraded and has changed in appearance. The two main changes are the option to include a recurrence graph, which traces what happened on during last solar rotation for comparison and potential expectation in the coming 3 days (each plot is the observation from T-minus 28 days). Also, the cadence of REFM forecast fluence data is reduced past day 1 to only one value per day. The cadence remains 3-hourly for the first 24 hours.